5.0 LCA SCIENCE AND TECHNOLOGY AGENDA

5.1 Objectives

The objectives of this section are to discuss the approach to establish the S&T Office, how the S&T Office would establish priorities for identification of science needs, determine how those needs would be implemented, and identify some investigations that may be initiated during the first three years of Plan execution. Scientific investigations executed through the S&T Office must address specific project execution needs using the best available science and technology. Program Management and the Program Execution Teams would identify priority project needs and the S&T Office would identify necessary science investigations and recommend those studies to Program Management to address those needs.

5.2 General Strategy for Plan Development

Establishing a strategy to systematically and effectively reduce uncertainty to a level where restoration projections can proceed with a reasonable probability of success is the primary goal of the S&T Plan. The general strategy to develop an action plan is comprised of three sub-strategies: (1) enhance program focus by systematically reducing scientific uncertainties, (2) increase efficient use of resources by prioritizing available resources, and (3) establish a program structure to enhance integration of science investigations that reduce uncertainties with the most efficient use of resources.

Each Sub-strategy is discussed below followed by the general form of a plan outlining science steps for the first three years of the S&T Plan. The general strategy would be updated on an "as needed" basis as part of active Adaptive Environmental Assessment and Management. The general strategy would be updated during the first year of program implementation when the Director is identified. Moves to focus the S&T Program and would be updated less often in subsequent years. Specific steps in the three-year action plan would be reviewed and possibly modified when the program is initiated and updated on an annual basis thereafter.

5.2.1 Sub-Strategy to Ensure Program Focus

LCA restoration would be implemented by construction and operation of specific projects that would enhance wetland restoration efforts. A variety of project alternatives are available, each with a different blend of cost, restoration benefit, and impact. Effective project selection must balance these project attributes. However, the clear differentiation between alternative projects, necessary for project selection, is clouded by uncertainties in restoration benefit and impact. The inadequate forecasting of ecosystem response causes this uncertainty. These uncertainties may result from either lack of scientific understanding or imprecise forecasting tools. Moreover, uncertainty is not uniform across all possible projects. Certain categories or sizes of restoration projects may be implemented with relatively little risk of failure whereas other projects categories may be associated with substantial scientific and technological uncertainty. This latter category of project should not be constructed until critical (i.e., project threatening) uncertainties are reduced to acceptable levels.

5.2.2 Sub-Strategy for Effective Use of Resources

Seven general sources of knowledge relevant to the LCA Plan that may be used to reduce uncertainty and thereby guide restoration planning. These knowledge sources can be ranked by increasing cost as:

1) Existing literature and information from other large, coastal restoration projects (e.g., the Everglades),
2) Available but uncollated and unsynthesized data collected under existing programs that can be acquired and analyzed in ways that support S&T Program goals,
3) Professional experience in a community of practice, particularly engineering, may address certain knowledge needs,
4) Bench-, microcosm-, mesocosm-scale studies,
5) Expansion of existing projects to serve as demonstration projects,
6) Field trials using intermediate-scale demonstrations, and
7) Prototype scale demos.

Approaches one to three are relatively low cost and can be implemented early in the 5-year program cycle if the necessary coordination and IT procedures are established early in the program cycle. Approaches four to seven involve direct experimentation, but at different scales. In approach four, uncertainties are reduced by using relatively controlled experiments to describe small-scale processes. Approaches five through seven all involve relatively large-scale, relatively uncontrolled experiments in which routine monitoring is used to describe system response. Approach five may also be relatively low cost depending upon the level of completeness of the existing demonstration. Approaches six and seven require more time for construction and scientific mobilization and should be delayed until approaches one, two, and three have provided information to help focus approaches four and five. Implementation of approach seven falls outside the three-year plan and should be considered as a long-term project in which knowledge gleaned using approaches one through six must be utilized for project planning for approach seven. Effective utilization of this sub-strategy requires the availability of the following items, all part of the S&T Plan:

8) A comprehensive IT plan to allow data and knowledge to be integrated seamlessly across all seven approaches,
9) A comprehensive monitoring plan that is essential to garner knowledge from approaches four to seven, and
10) An integrative model framework that can be used to archive knowledge in a form that can be used directly to support project design, siting, and operation.

5.2.3 Sub-Strategy for S&T Program Structure and Integration

Previous and anticipated research to support the LCA Plan is characterized by studies from various disciplines that typically work on different subsystems or ecological processes within ecosystems. This sub-strategy would be used to assemble and integrate the tools of different disciplines in order to develop a system of forecasting tools to support LCA restoration. The sub-strategy would provide science and engineering capabilities that allow the action agencies to understand the systemic consequences of restoration projects over broad temporal and spatial scales. The capabilities would include science-based water resources management methodologies, implementation guidance, and computational frameworks and technologies that support decision-making. These capabilities would be built from sound, scientific principles reflecting an improved understanding of interrelationships among key system attributes such as hydrology, hydraulics, geomorphology, chemistry, ecology, and socio-economics. Capabilities would be served through an integrated architecture allowing projects to be considered at multiple-scales during project planning, design, construction, operation and maintenance.

The sub-strategy would have four broad topic areas and a unifying technologies area. The topic areas include 1) Water dynamics (including estuarine and coastal dynamics); 2) sediments, water quality, and geomorphology; 3) ecological response; and 4) socio-economic response. This structure is recommend for three important reasons: 1) tools used for ecosystem management can be typically categorized using this structure, 2) IT frameworks that support interdisciplinary integration require at least this level of discipline-specific program resolution (although additional levels may need to be added), and 3) this structure is consistent with the new CE system-wide R&D program scheduled to start in 2005. This last point is particularly important because the CE system-wide program would develop tools that can be used to restore a number of river and coastal ecosystems. Continuity in the S&T Program structure between LCA and the CE system-wide program would ensure that tools developed by any restoration program of national importance can be easily exported to another. For example the CE system-wide program plans to develop a River Basin Morphology Modeling and Management System and a Coastal Morphology Modeling and Management System. The cost effectiveness of such a strategy is obvious.

5.3 Specific Tasks for S&T Plan Implementation

This portion of the S&T Plan provides a brief description of the tasks necessary for formation of the S&T Office, the process for execution of the S&T Plan, and the schedule of tasks planned during the next few years. Given the uncertainty of funding and sequence of project execution during these first few years, the S&T Plan is fairly general. However, as particular projects are identified for early execution during the near-term, priority studies would be initiated to establish baseline conditions and to, subsequently, to determine how effective each project was at achieving its intended objectives.

Execution of the S&T Plan and identification of specific studies should be accomplished with significant input from scientists within Louisiana as well as those outside of the state. The modeling effort, discussed in detail in Appendix C of this report, has performed a substantial amount of work to develop the initial models for assessment of ecosystem response. That effort clearly identified several data needs and that team should be fully engaged, as the S&T Office becomes functional. Therefore, this section of the report proposes that the following tasks be accomplished in the first years of implementation: (1) establish the S&T Office and hire the Director, (2) establish the Science Coordination Board to coordinate LCA Plan activities with other scientific research programs and identify potential opportunities for leveraging funds, (3) establish the Science Advisory Board, (4) initiate review of existing information prior to data collection, (5) develop an Information Management Architecture to handle the different types of data available and anticipated, (6) work with the Program Execution Team to identify future project schedule projections and identify necessary analytical tools to meet those needs, (7) initiate priority research investigations as time and resources permit, and (8) prepare the Annual Adaptive Management Report. Additional priority research would be identified in subsequent years. The LCA Approach to achieve these tasks is presented below.

5.3.1 Establish the S&T Office

Scientific studies for LCA projects should be initiated and coordinated through the S&T Office. Scientific investigations would be interdisciplinary and inter-institutional and awarded on a competitive basis. Scientists participating in the science effort would be expected to provide results in a form usable by the LCA Program Execution Team and in accordance with Program Execution Team schedules *and* publish results in peer-reviewed scientific journals.

Administrative staff for the S&T Office would include an Administrative Assistant (1 FTE), one person (1 FTE) to handle fiscal resources, and two persons to handle contracting (2 FTEs). The fiscal and contracting persons may be located within the District, but must be dedicated full time to the S&T Office.

5.3.2 Establish the Science Coordination Board

Efforts have already been initiated to inventory research programs by Federal agencies and academia and this effort would be expanded as the S&T Office becomes operational. The Science Coordination Board may have representation from the USACE Center of Expertise for Ecosystem Restoration, the Governor's Applied Coastal Research and Development Program, the Coastal Restoration and Enhancement Through Science and Technology (CREST) Program, Pontchartrain Restoration Program, and other organizations as appropriate.

5.3.3 Establish the Science Advisory Board

The Science Advisory Board would be composed of independent, National Academy of Science level, coastal restoration experts. This Board would be convened at regular intervals on a contract basis to review the Program.

5.3.4 Initiate Review of Existing Information

Abundant, multi-disciplinary data archives exist in both public and private sectors that would be extremely valuable to LCA project planning, design, implementation, and monitoring efforts. Information exists in a wide diversity of formats from historical maps and aerial photography to hydrodynamic data, historical ecological data sets, demographic information and more. Data acquisition of physical, hydrodynamic, and ecological data is ongoing and future data mining of these resources is being planned and implemented. These data sets are important in establishing baseline conditions (essential to measure restoration performance), for developing status and trends in the conditions of natural resources, and gaining greater insights in project planning, implementation, monitoring, and evaluation. Clearly, Louisiana has a rich history of scientific studies within the coastal system. However, it is necessary to assess this information, clearly identify what is known and what is not known, and clearly define gaps in our understanding, so that planning efforts may more fully utilize the human and fiscal resources available to the S&T Office and avoid duplication of the expenditures of these resources.

5.3.5 Develop Information Management Architecture

Information technology is a part of every component of the LCA program. Therefore, the Director’s office must be involved in the conduct of information technology activities. The Director’s office should not physically do, or necessarily lead, information technology development, but must be intimately involved in the planning, development, and distribution of information technologies.

The first information technology task that must be undertaken for LCA Plan is the development of a technical architecture for all LCA Plan products. The purpose of a technical architecture is to define the standards and procedures that scientists and engineers would use in LCA Plan. Among others, there would be standards for spatial and scientific data, frameworks for working with multi-dimensional models and decision support tools, and web-site/portal products. Early definition of standards in the technical architecture would “bake in” interoperability and reusability into LCA Plan products. The size and complexity of the LCA program must have a detailed technical architecture to be technically and financially successful. A technical architecture for LCA Plan can be completed in the first year.

5.3.6 Identify Future Project Schedules

The Director would work closely with LCA Program Management and the Program Execution Team to sequence scientific investigations. Data would be collected prior to project execution to ensure that appropriate baseline information is available and can be used to make pre-project and post-project comparisons and to effectively analyze project results.

5.3.7 Potential Priority Scientific Investigations

The S&T Office and Program Execution Team would identify potential priority studies and analytical tools necessary to reduce scientific uncertainties and meet project needs. Ongoing investigations on Hydrodynamic and Ecosystem Restoration Modeling and the study on Barrier Island and Shoreline Restoration should be examined and considered for future studies and a study on River Management and Engineering would also be considered. These broad studies would provide valuable information for all near-term, long-term, and demonstration projects. Additional studies would be identified as needed during the first year of execution. A brief description of each of these efforts is presented below.

5.3.7.1 Hydrodynamic and ecosystem restoration modeling

The LCA Comprehensive Ecosystem Restoration Plan would establish a modeling framework to provide analytical tools to address Louisiana coastal problems and opportunities for wetland rehabilitation. The early modeling effort supported the LCA planning process by developing preliminary conceptual ecological models of coastal Louisiana. The initial step of this conceptual model was to define disturbances, sources of ecosystem stress, and development of desired ecosystem response. These assumptions were based on causal linkages between disturbances, ecological effects, and desired ecological endpoints or restoration responses. These responses required an understanding of the present ecosystem state, desired endpoints, and necessary site conditions to obtain specific endpoints. Initial work on this conceptual model accomplished a description of these objectives, targets, and desired endpoints; the results of this effort are described in each of the five modules used to simulate system response in Appendix C (Hydrodynamic and Ecological Models).

Continued development of these conceptual and simulation models to further develop an applied science strategy that would support the monitoring and adaptive management efforts within the LCA ecosystem restoration plan is required. The early modeling effort provided a modeling tool that has been used to evaluate restoration alternatives along with ecological benefits using a combination of modules that predict physical processes, geomorphic features, and ecological succession. This modeling program has documented the assumptions and limitations of such an effort, and provided guidance for the improvement of this procedure to reduce scientific uncertainty in model forecasts of restoration projects.

5.3.7.2 Barrier Island and shoreline restoration program

The emphasis of this ongoing investigation is the assessment of Louisiana's critically eroding Gulf shoreline (barrier islands/mainland), and the communities at risk, the modeling of critical coastal processes, and the identification of sediment resources for the development of engineering and management solutions to coastal restoration. Critical processes driving the erosion of Louisiana's Gulf shoreline are a combination of high rates of subsidence manifested in relative sea level change, repeated storm impacts, a diminishing sediment supply, complex patterns of sediment dispersal, and other poorly understood processes of erosion. The Adaptive Management of CWPPRA's Gulf shoreline restoration projects constructed in the Isles Dernieres, Timbalier Islands, and Holly Beach has provided many lessons learned. These may evolve into guiding principles for LCA near-term, demonstration, and long-term Gulf shoreline restoration projects with further investigations.

The success of the restoration of Louisiana's Gulf shoreline requires knowledge of the framework geology and the available sediment resources (Appendix D). Additional knowledge of the complex erosive processes acting on the Gulf shoreline is essential to restoration project design through ongoing Sand Sediment Resources Team (SSRT) coastal geomorphic and sediment budget change analysis. The formulation of coastal process models of sediment dispersal coupled with geomorphic change are critical to predict and achieve LCA Gulf shoreline restoration targets. Coastal engineering solutions to shoreline erosion would require a greater understanding of the temporal and spatial processes acting along Louisiana's coast.

This work has compiled previous research and identified key strategies and approaches to restore and protect the Gulf shoreline and provide broader protection to wetlands and infrastructure. The framework for a conceptual model initiated in Appendix D has been further developed to include consideration of the mixed deltaic sediment headland erosion mechanisms and mud/sand interface and interaction. The dynamic morphosedimentary model requires additional field measurement to calibrate and define the distinct break in slope observed in the submerged profile that defines the eroding shoreface. The percent sand in the islands and distribution of sand across the profile also need to be determined by field measurement. Once these field assessments are made the model can be applied to each coastal segment to provide a complete longshore and cross-shore, littoral budget for sand and fine sediment (for each coastal segment) using the measured retreat rates of the shoreline. Coastal restoration projects can then be evaluated for initial and long-term sediment needs with comparative analysis of various fill sources and construction templates. Adaptive Management analysis of existing and planned CWPPRA would be an ongoing process in order to continue to provide new insights into the engineering design of restoration templates for near-term, demonstration, and long-term LCA Gulf shoreline projects.

A regional approach to sediment management is vital to the long-term success of the coastal restoration program. Sand resource mapping and projected use scenarios would be prepared in a decision matrix format appropriate for regional plan development and comparison. Dredging equipment and cost evaluations would be made to establish feasibility level information appropriate for this level of planning. Needs for further offshore investigations and mapping would be identified.

The role that coastal structures can play in coastal restoration and protection would be evaluated. The performance of existing breakwater and other structural systems would be detailed. Applications where structures can be used to improve the long-term performance of restored coastlines and islands would be identified. Cost effectiveness would be the key criterion in the evaluation for the recommendation of specific structural applications. The above analysis would enable development and evaluation of:

- A project level preliminary design of all island and headland segments with costs, and
- A suggested first phase test program that would target uncertainties with a monitoring and feedback adaptive management system to improve scientific understanding and design approaches.

5.3.7.3 River management study and engineering program

The main focus of this study would be the generation of a water budget analysis of the Mississippi River. This effort is a critical starting point in the development of long-term restoration plans. Daily discharge data (1935 to present) are available for the Mississippi River at Tarbert Landing. This database gives a sound basis for developing a statistical analysis of flows in the lower Mississippi River. The discharge information must be representative of any ongoing or future operation of the MR&T flood control system and/or make allowance for any contemplated changes. The water budget analysis must take into account riparian users, navigation, and flood control needs. An LCA plan for use of the river's resources must be developed so that restoration efforts can be directed in the most efficient approach. Central to this issue would be the establishment of realistic restoration goals that take into account the various demands that are placed on the river's resources. It cannot be over-emphasized that the use of the Mississippi River as a resource for coastal environmental restoration is complicated by a host of potentially conflicting demands on that resource.

Selecting the proper location and sizing of a diversion structure go hand in hand. The size or capacity of a structure is proportional to the time-based, land-building scales that are established for the receiving area of any proposed diversion. Conceptually, it seems apparent that the ability to build land in a specific receiving area would be proportional to the volume of water placed in the area via a diversion structure and the concentration of sediments contained in that volume of water. However, in practice, a process-based determination of the land building is perhaps one of the most challenging problems that water resource engineers and scientists confront. Many, if not all of the forcing functions that act on a diversion system are stochastic in nature, and when considered from process-based, deterministic approach, defy existing scientific methodologies. The methodology employed in the current effort relies on averaging long-term observations of these forcing functions. For the Mississippi River, average monthly discharge and sediment concentrations were used. A Risk-Based Analysis approach to the problem of river diversions and expected outputs would need to be considered in future work, so that planners can better understand the uncertainties involved.

In general, planned diversions may be grouped into two classes, controlled and uncontrolled. Uncontrolled diversions, as the name implies, allows for diversion of river flow through an open channel that connects the river to the receiving area. The amount of flow to the receiving area is controlled by the hydrologic cycle of the river and the size of the opening in the riverbank as well as other factors discussed below. Controlled diversions imply that some sort of gated control structure is used to regulate the amount of flow passing into the receiving area. Controlled structures can be operated either as run-of-the-river structures (i.e., allowing the river's hydrologic cycle to dictate discharge) or, as pulsing structures where gates are opened and closed to meet specific timing of flow requirements to the receiving area. Engineering calculations and procedures needed to size a proposed structure and delivery channel (when seeking to optimize the delivery system from the standpoint of total cost) result in a thorough understanding of the discharge capacity of a proposed structure. In general, for a given discharge in the Mississippi River, the further up river one goes the greater the potential head becomes, since for the most part the receiving areas are located at or near sea level. The combination of head and discharge constitutes a measure of the power available to force flow and sediment to the target area. Therefore it would seem obvious that upstream structures, at least in theory, can be smaller in size for a specified diversion discharge capacity than ones having the same discharge capacity located some distance downstream. The problem with this reasoning is that many of the target receiving areas are located near the coastal zone and the channels lengths needed to move flow and sediment to the target area become larger, longer and more expensive to construct as distance from the target receiving area increases. So, proximity to the receiving or target area is an important factor in locating a proposed structure. Therefore, proper selection of location and sizing a LCA system of diversion structures is not a trivial matter and proper planning and forethought must be done to take full advantage the Mississippi River as a source of sediment and nutrients.

5.4 Making Adaptive Management Work

The structures and process outlined here for the LCA Science and Technology Program provide the important elements of an adaptive management program. However, really making adaptive management work means that all participants involved in the LCA Restoration Plan acknowledge that implementation is a learning process, and adaptation must occur. Recognizing that structures would develop and change over time, the specific program elements proposed here are designed to promote learning and adaptation from the start – rather than making adaptive management a concept added on to the existing restoration planning. The LCA Restoration Project would provide an opportunity for participants to begin adaptive management in the early stages of program planning.

5.4.1 <u>The Need to Promote Learning in LCA</u>

Conceptual and predictive models represent the current status of understanding the natural system, and as such are important vehicles to capture the learning that is essential during the adaptive management approach. The revision of models represents a learning process and is the feedback that corrects restoration implementation and helps direct future planning efforts. The challenge is to communicate this potentially complex body of information to scientists, planners, managers, stakeholders, and partners to provide for learning. This would be done through the following:

5.4.1.1 Synthesis of monitoring data

Synthesis of monitoring data and analysis is a key link in the AM process. A key role of the S&T Office is to produce periodic synthesis documents for Program Management and the Program Execution Team that both summarize monitoring data and use the data to verify existing models. The monitored data can provide support for, or lead to modification of, the essential ecosystem characteristics of a conceptual model that has been reviewed and accepted by the public and scientific community. Further, modeling synthesis documents can focus future monitoring, or targeted research, on areas of greatest variability or restoration risk.

5.4.1.2 Evaluation of experimental manipulations

The enhanced value of scientifically designed and adequately monitored, large-scale experimental manipulations derives from the inferences that can be drawn from their results. For example, it should be possible after a period of diversion operation at a certain discharge regime to not only know how plant composition and distribution at the receiving area changed, but what the likely results would be if the duration or timing of the operational regime were modified in the future. Clearly there would be limited "learning" returns from the extensive monitoring of projects that are primarily intended to repeat well-known and tested management actions. However, innovative and untested actions should be considered not just as important learning opportunities but perhaps the only learning opportunities that exist, and therefore they should be supported with strong scientific designs and monitoring programs.

5.4.1.3 Report card

One developing form of reporting on system management performance is the environmental report card (Harwell et al., 1999). As all of us are familiar with report cards from our school years, this familiar manner of evaluating performance can be usefully applied to environmental management programs. An environmental report card presents summary status information on ecosystem endpoints, and it communicates progress of management in improving ecosystem health. Being a communication tool, the report card should be easily understood by a range of audiences. It should communicate the status of the system in terms of endpoints, and reflect trends over time to judge progress. Finally, the method for assigning ratings or grades should be easily understood and clearly based on endpoint definitions and measures. The best formats for progress reporting should make it easy for users to understand the desired endpoint value, current status relative to the endpoint target, and trend through time in status change.

There is no standard format for an environmental report card. However, some common elements of environmental performance reporting are seen in the report cards on ecosystem management by state and federal agencies in the Everglades, Chesapeake Bay, and San Francisco Bay. Performance reporting on the Everglades (McLean and Ogden 2000) and Chesapeake Bay use one simple bar chart or line graph for each endpoint showing annual measurement values by year. These graphs also clearly show the desired endpoint value for readers to readily judge status and trend.

5.4.1.4 Science symposia

The scale and complexity of the Louisiana coastal ecosystem and the expected variety of restoration activities that will be ongoing under LCA mean that few scientists, if any, would be fully aware of the status of scientific understanding. To promote dissemination of current findings, discussion of new ideas, and cross-disciplinary interaction, the S&T Plan would regularly hold a Science Symposium providing a common forum for presentation of results and progress in restoration science. This would be modeled after the already established and successful CALFED Science Conference and the Greater Everglades Ecosystem Restoration Conference – each of which is held biennially. These venues provide excellent opportunities for stakeholders, as well as scientists, to stay abreast of current scientific developments pertinent to ongoing ecosystem restoration efforts.

5.4.1.5 The annual science report and plan

In order to clearly identify the changing scientific needs of LCA implementation, the S&T Plan would annually prepare a ‘Science Report’ summarizing progress, identifying challenges and unmet needs, and providing some accountability for the funds expended on S&T Plan activities. This would be prepared by the SCB and would encompass LCA supporting science efforts, funded by agencies of other LCA-independent entities, as well as activities specifically funded by LCA. Emerging from the Science Report would be an accompanying annual Science and Technology Plan, which would articulate the activities of the program in the next year as part of a multi-year vision for LCA science needs.

5.4.2 Adaptation - Closing the Adaptive Management Loop

Learning and adaptation are the elements of an adaptive management process that close the feedback loop and begin the iterative process over again. In this phase of the process, information, in the form of monitored data, the results of demonstration projects and other focused studies, and predictive models are combined to yield either confirmations of existing beliefs, or new descriptions of system status and explanations of the factors that control the system. Over multiple iterations of the adaptive process, a new understanding of how the system operates may even result in the reformulation of goals and objectives.

The concept of adaptation is relatively simple. Disciplined adaptation, however, within a program that addresses the desires of many different stakeholders, is a difficult process to implement and control.

In addition to the many other problems associated with implementing adaptive management discussed in the LCA Report and in this appendix, there is also the question of "When to adapt?." While the acquisition of some information can be planned (e.g., from a controlled experiment or a monitoring program), other information arrives unexpectedly. The ability to acquire knowledge about the response of the delta-building process to periodic, large-scale disturbances cannot be predicted.

Adaptive management of any large ecosystem requires both the ability to change on a regular, predictable schedule, and also, if necessary, in rapid response to unpredicted events. Given what we know about year-to-year variability of riverine and meteorological drivers, it seems realistic to consider establishing a regular system status review on a time schedule of 5 years. However, a rapid response decision-making mechanism should be considered as a vital element of a future adaptive management process.

Finally, LCA stakeholders and partners, as they continue to refine a more integrated goal-setting process, must consider the importance of well-thought-out, long-term goals, and the need to take a conservative approach to changing those goals from one adaptive interval to another. The restoration of desirable conditions for many of the ecosystem elements of the Louisiana coastal ecosystem is likely to require decades rather than years. Success would require unwavering commitment as well as vision.

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